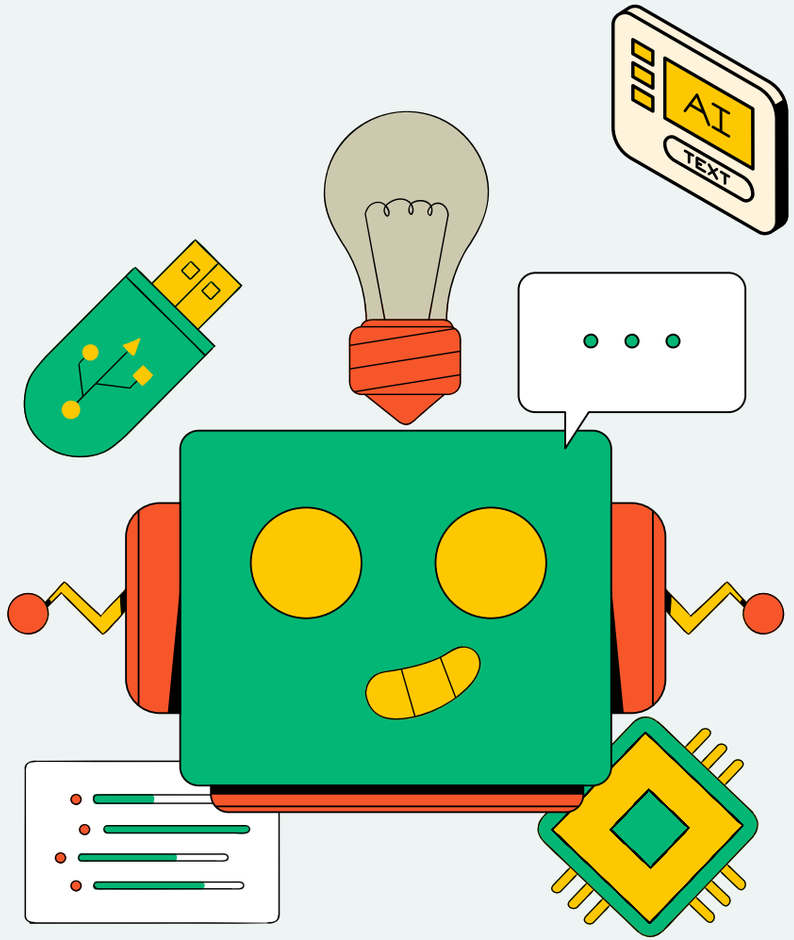
APAI3799

DIRECTED STUDIES IN APPLIED AI



BUILDING AN ONTOLOGY-BASED BLOCKCHAIN APP FOR EDUCATION.

PRESENTED BY:

KWOK SHI MING JASMINE

PRESENTATION OUTLINE

1. Background
2. Key Concepts
3. Research Method
4. Demonstration of the working product
5. Future Development

BACKGROUND

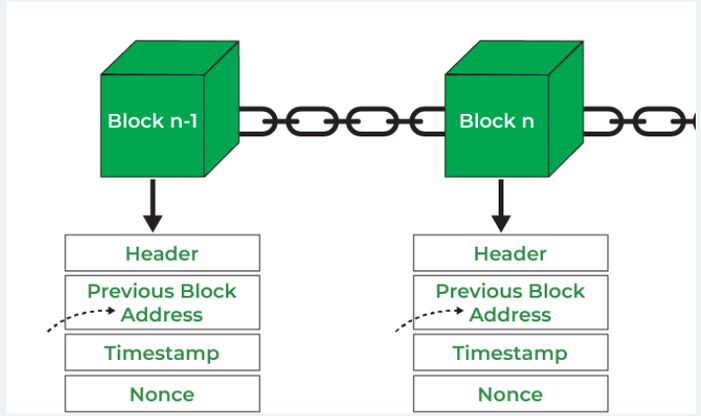
Limitations of the current curriculum development:

- Fixed, not dynamic
- Skill misalignment with industry
- Not interdisciplinary

Proposed Solution:

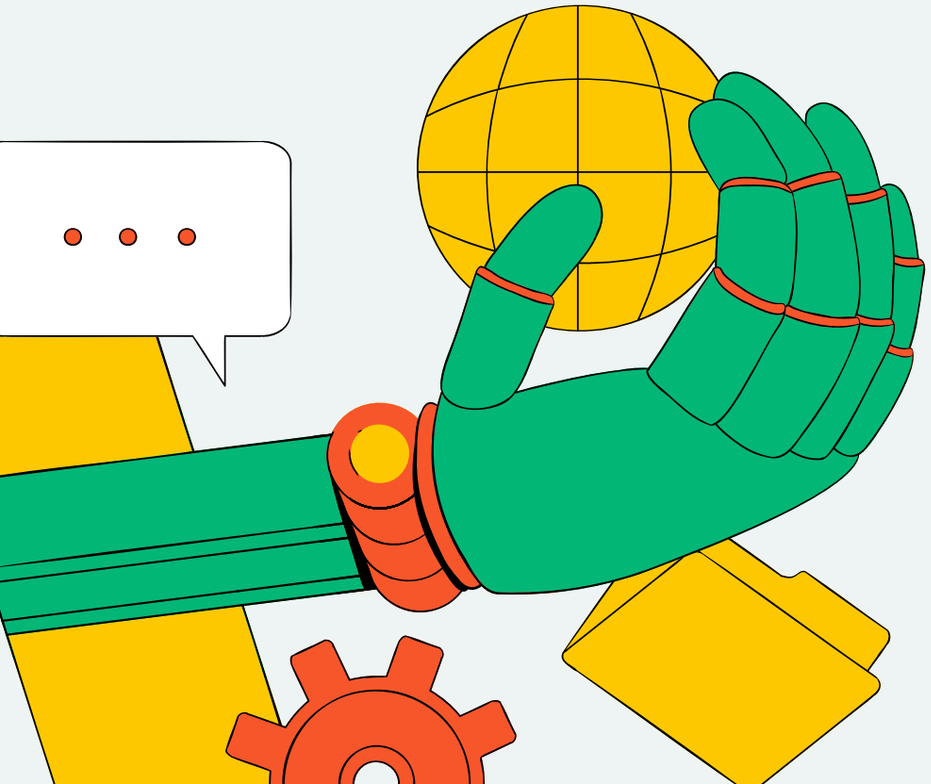
- Building an **Ontology-based Blockchain Application** for Education

WHAT IS BLOCKCHAIN?



Key Features:

- Immutability
- Transparency
- Security
- Consensus Mechanisms
- Smart Contracts



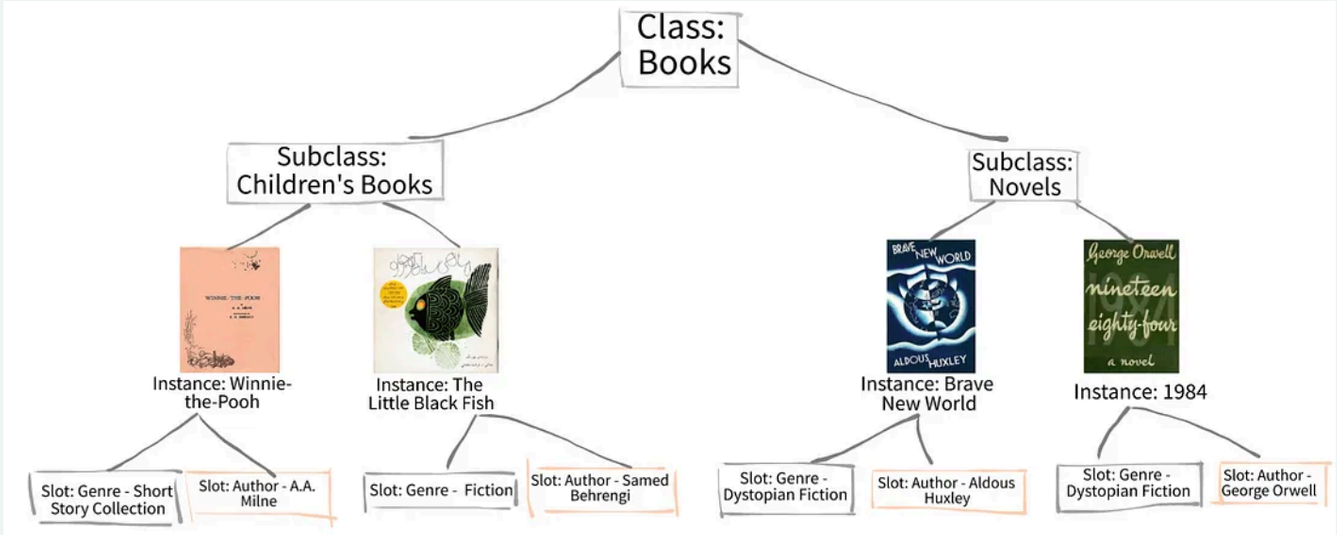
Centralized vs Decentralized:

- Controlled by a single authority
  - E.g. Traditional banking systems.
- Distributed across a network of nodes
  - E.g. Bitcoin, Ethereum.

WHAT IS ONTOLOGY?

- **Definition:** Ontology is a structured representation of knowledge within a specific domain, defining concepts, relationships, and rules.

- **Purpose:** Facilitates knowledge sharing, semantic interoperability, and automated reasoning.



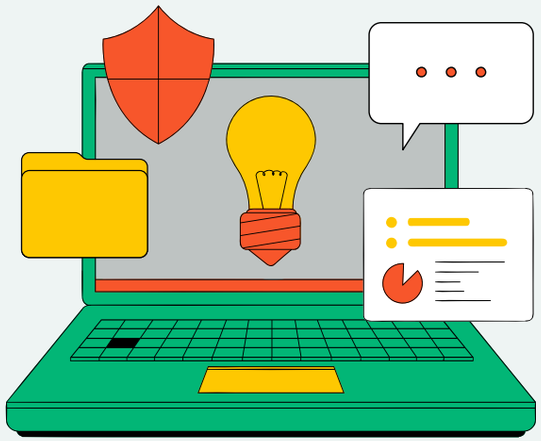
THE INNOVATION

A centralized blockchain application to support dynamic curriculums alongside an AI that predicts learning scores which is trained with an ontology of different disciplinaries

+

An Ethereum-based application to support the exchange of learning contents in the form of NFTs

= A Dedicated NFT Marketplace for Education



RESEARCH PROBLEM

How to use centralized and decentralized blockchains to build an NFT marketplace for education

How to predict learning scores for students based on the learning contents they have learnt from the blockchain

Scope: ESG (environmental, social, and governance)

RESEARCH METHOD

Components of the NFT Marketplace:

01

HORIZONTAL BLOCKCHAIN MANAGEMENT

Developing an API to access a database server of blockchains in which each of the blockchain represents a student's learning history according to the transactions of NFTs created on the marketplace

02

VERTICAL BLOCKCHAIN MANAGEMENT

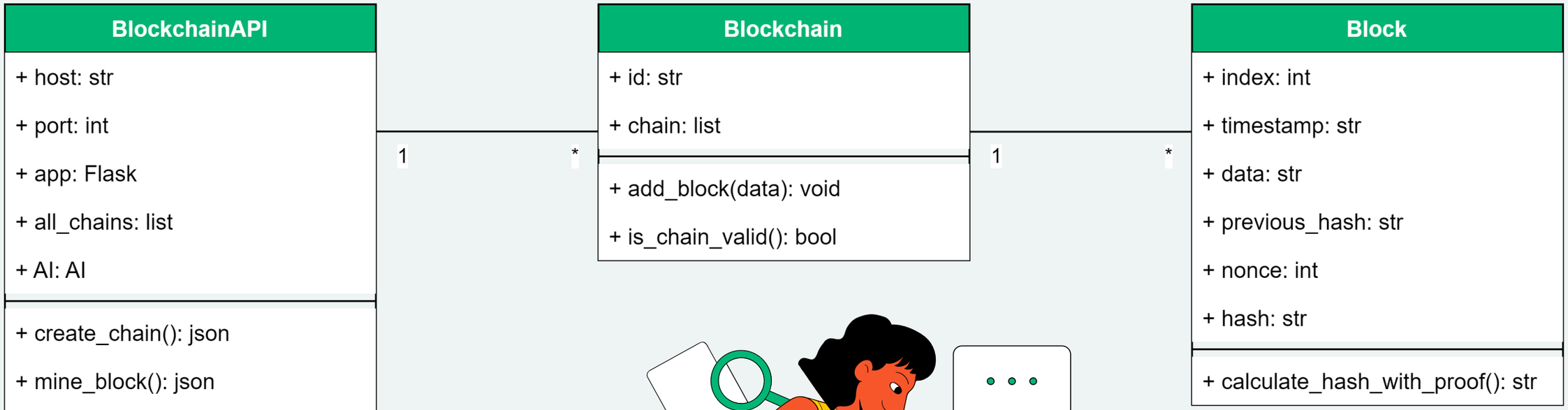
Developing a smart contract to process transactions of NFTs on the Ethereum network

03

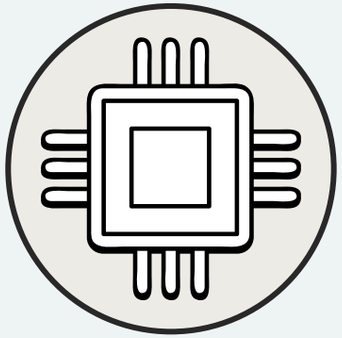
PREDICTION MODEL

1. Building an ontology for ESG
2. Preparing the dataset
3. Fine-tuning the BERT model
4. Calculating the ESG scores from the predictions of the model

01 - HORIZONTAL BLOCKCHAIN MANAGEMENT



02 - VERTICAL BLOCKCHAIN MANAGEMENT



ERC721 & ERC2981
SMART CONTRACT

CONSTRUCTOR

creator address, name, symbol

SAFEMINT

metadata uri, royalty percentage, price

STARTSALE

token id, price

CANCELSALE

token id

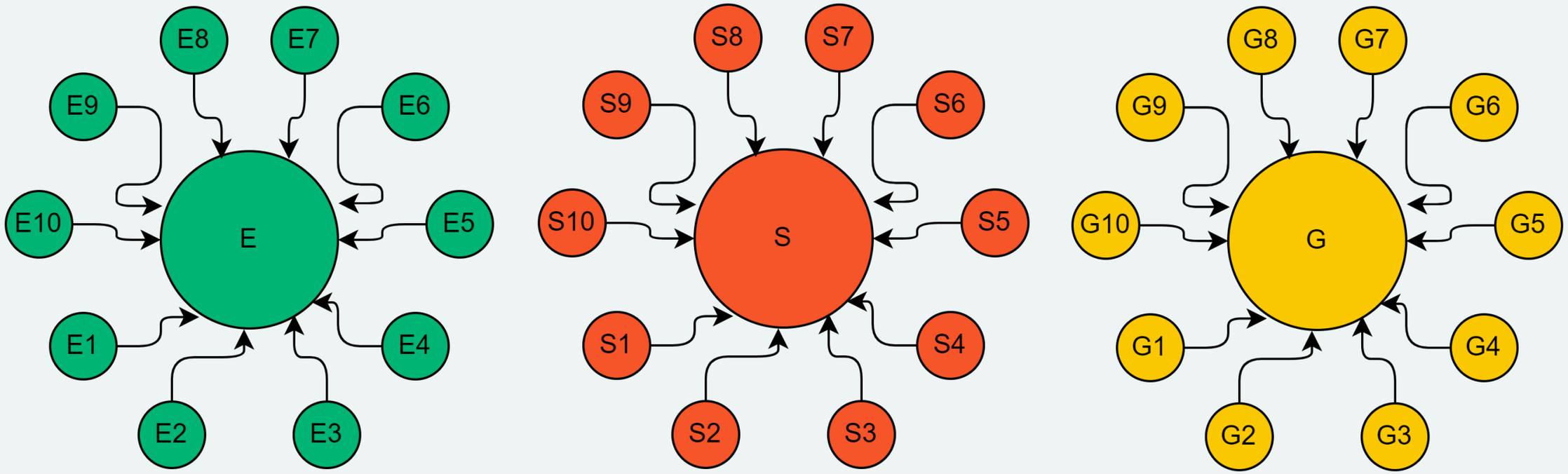
BUYNFT

token id

03.1 - PREDICTION MODEL: BUILDING THE ONTOLOGY FOR ESG

10 subtopics for each of E, S, and G, 30 in total, defined with the help of ChatGPT

e.g. E1 = “Climate change and carbon footprint”



- E1: Climate change and carbon footprint
- E2: Renewable energy and energy efficiency
- E3: Water management and conservation
- E4: Biodiversity and ecosystem preservation
- E5: Pollution control and waste management
- E6: Environmental regulations and compliance
- E7: Sustainable agriculture and land use
- E8: Green buildings and infrastructure
- E9: Environmental impact assessments
- E10: Supply chain sustainability and responsible sourcing

- S1: Human rights and labor practices
- S2: Diversity and inclusion in the workplace
- S3: Employee health and safety
- S4: Community engagement and development
- S5: Stakeholder management and accountability
- S6: Consumer protection and product safety
- S7: Social impact investing and philanthropy
- S8: Ethical marketing and advertising practices
- S9: Humanitarian initiatives and disaster response
- S10: Social equality and poverty alleviation

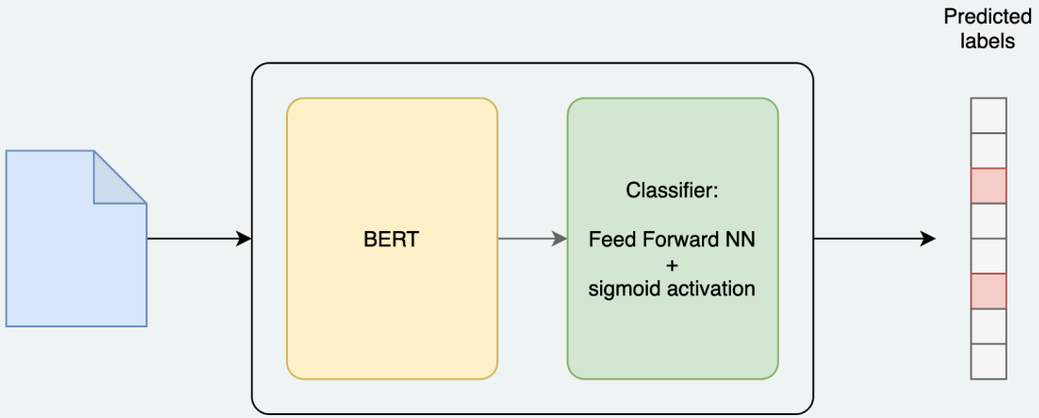
- G1: Board structure and independence
- G2: Executive compensation and performance metrics
- G3: Shareholder rights and activism
- G4: Transparency and disclosure practices
- G5: Anti-corruption and bribery measures
- G6: Risk management and internal controls
- G7: Ethical decision-making and code of conduct
- G8: Political contributions and lobbying
- G9: Data privacy and cybersecurity
- G10: Stakeholder engagement and dialogue

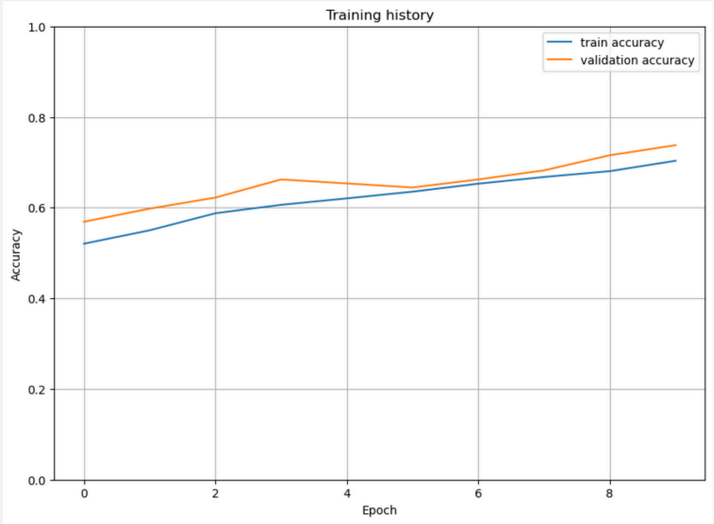
03.2 - PREDICTION MODEL: PREPARING THE DATASET

- 1 column for the combined course information (title + description)
- 30 columns representing the presence of each subtopic in the course (1 if the subtopic is present, 0 otherwise)
- 100 samples were obtained from the internet, labelled manually
- Split and randomize: Train: (70, 31), Test: (15, 31), Valid: (15, 31)

	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	...	G2	G3	G4	G5	G6	G7	G8	G9	G10	combined
0	1	1	0	0	0	1	0	0	1	0	...	0	0	0	0	0	0	0	0	0	How to transform the energy system and reduce ...
1	1	1	0	0	0	1	0	0	1	0	...	0	0	0	0	0	0	0	0	1	Renewable Energy Sources Cut Carbon Emissions,...
2	1	1	1	0	0	1	1	1	1	0	...	0	0	1	0	0	0	0	0	0	Renewable Energy Sources and Climate Change Mi...
3	1	1	1	1	0	1	1	1	1	0	...	0	0	0	0	0	0	0	0	0	Climate Change. The Ecological Footprint frame...
4	1	1	1	1	1	1	1	1	1	1	...	0	0	0	0	0	0	0	0	0	Climate Change. Across the globe, TNC is tackl...

03.3 - PREDICTION MODEL: FINE TUNING THE BERT MODEL





Adaptation of 'bert-base-uncased'

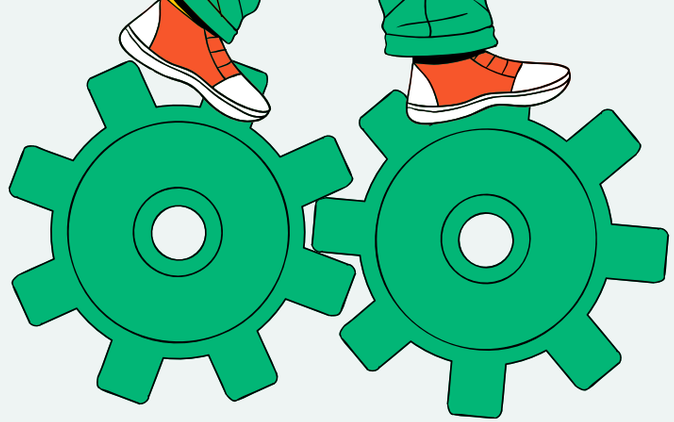
Additional output layer with a feed forward neural network with sigmoid activation

$$S(x) = \frac{1}{1 + e^{-x}}$$

0-1 prediction score for each labels

Test accuracy = 74%

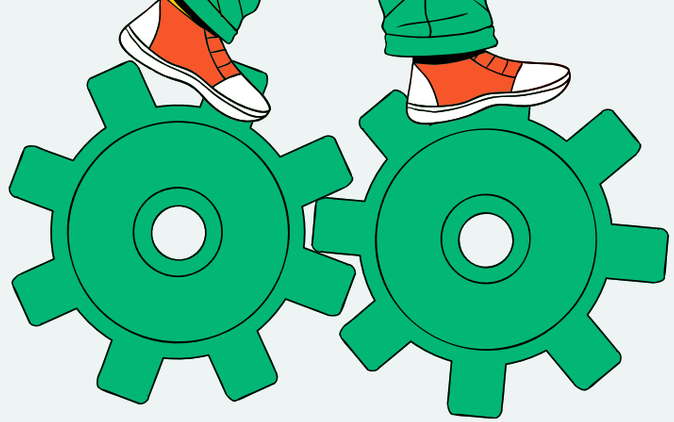
03.4 - CALCULATING THE ESG SCORES



Assumptions:

- The prediction probabilities obtained from the fine-tuned BERT model implies the proportion of the subtopics taught in the courses.
- Even if courses overlap in content, repeated learning of subtopics implies a deeper understanding, thus accruing higher learning scores.
- A cap of 1 is set for the total scores of E, S, and G such that when the accumulated learning score exceed 1, it indicates that a learner has fully met the certificate requirements for that topic.

03.4 - CALCULATING THE ESG SCORES



Integration with the Horizontal Blockchain:

EXTRACTION

Extract course titles and descriptions from the blockchain

PREDICTION

Topic detection by using the fine-tuned BERT model

NORMALIZATION

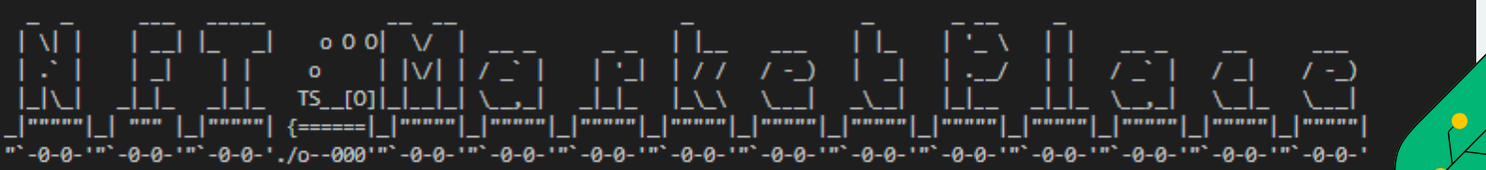
1. Normalize the result by (p – 0.5)/0.5
2. Remove weakly detected subtopics (critical threshold < 0)

SUMMATION

Sum up the probabilities for each subtopics with a weight of 0.1 (Each subtopic is 1/10 of E, S, and G), cap maximum of 1

DEMONSTRATION OF THE WORKING APP

```
(base) C:\Users\JK\OneDrive - The University of Hong Kong - Connect\0_General\BASc(APAI)\Y4\Y4_S2\APAI 3799\src>python NFTMarketplaceClient.py
Enter wallet address: 0xCF20388C9D28Dd29519817e9550D4dB03Dd35d89
Enter private key: 0a625f238865c230af48d7fb3c229e5d1afb5a00164f8797cceeb2bcea0129ec
Login success!
```

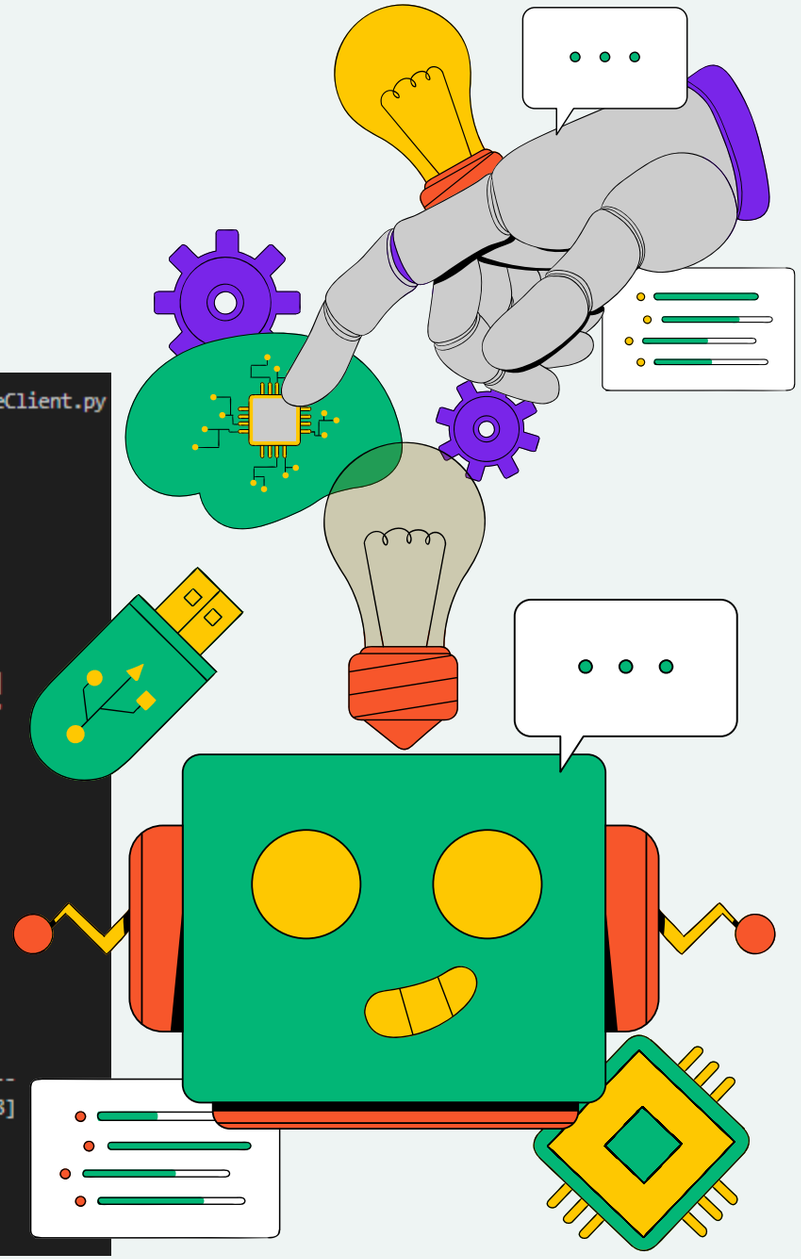


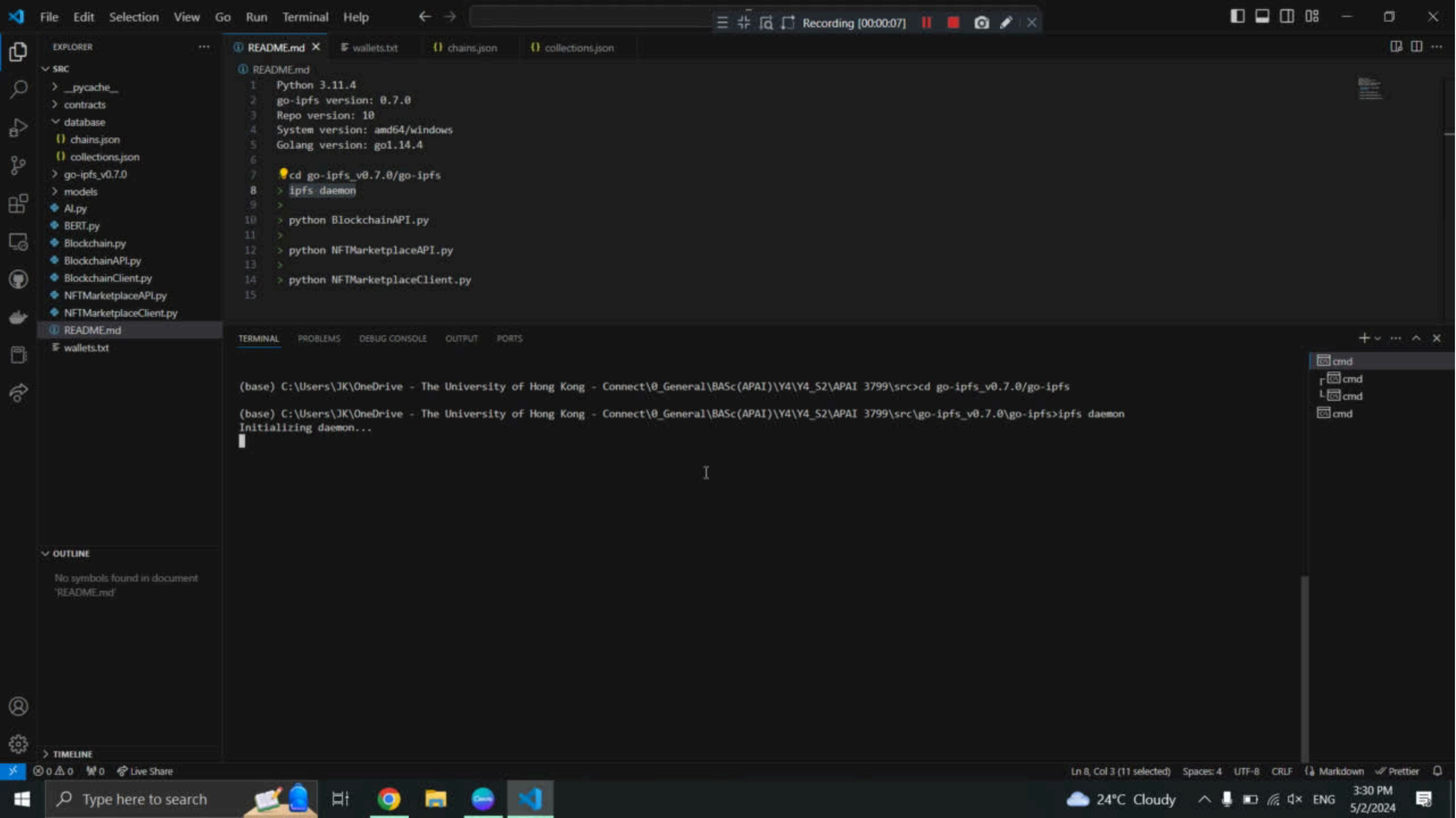
```
wallet address: 0xCF20388C9D28Dd29519817e9550D4dB03Dd35d89
balance: 0.206404 ETH
==============================
1 - Create NFTs
2 - Discover NFT Collections
3 - My NFTs
4 - My Learning Profile
==============================
Enter option: 4

timestamp           title    description    transaction hash                                                    [E, S, G]
------------------  -------  -------------  ------------------------------------------------------------------  --------------------
2024-04-30 00:31:16  asd      asd            0xf0e767f7d64144a3feef4408e6236d337f49dc842ecc7c4bb45a37505076c301  [0.056, 0.046, 0.068]

Total ESG scores: 0.056, 0.046, 0.068

Horizontal blockchain validity: VALID
```




File Edit Selection View Go Run Terminal Help
Recording [00:00:07]
EXPLORER
SRC
__pycache__
contracts
database
chains.json
collections.json
go-ipfs_v0.7.0
models
AI.py
BERT.py
Blockchain.py
BlockchainAPI.py
BlockchainClient.py
NFTMarketplaceAPI.py
NFTMarketplaceClient.py
README.md
wallets.txt
README.md
wallets.txt
chains.json
collections.json
README.md
Python 3.11.4
go-ipfs version: 0.7.0
Repo version: 10
System version: amd64/windows
Golang version: go1.14.4
cd go-ipfs_v0.7.0/go-ipfs
ipfs daemon
python BlockchainAPI.py
python NFTMarketplaceAPI.py
python NFTMarketplaceClient.py
TERMINAL
PROBLEMS
DEBUG CONSOLE
OUTPUT
PORTS
(base) C:\Users\JK\OneDrive - The University of Hong Kong - Connect\0_General\BASc(APAI)\Y4\Y4_S2\APAI 3799\src>cd go-ipfs_v0.7.0/go-ipfs
(base) C:\Users\JK\OneDrive - The University of Hong Kong - Connect\0_General\BASc(APAI)\Y4\Y4_S2\APAI 3799\src\go-ipfs_v0.7.0\go-ipfs>ipfs daemon
Initializing daemon...
cmd
cmd
cmd
cmd
OUTLINE
No symbols found in document 'README.md'
TIMELINE
Live Share
Ln 8, Col 3 (11 selected)
Spaces: 4
UTF-8
CRLF
Markdown
Prettier
Type here to search
24°C Cloudy
ENG
3:30 PM
5/2/2024

FUTURE DEVELOPMENT

- Build a web client with more front-end features
- Deploy the the marketplace on a dedicated remote server
- Extend the model to predict other disciplines
- Retrain the model with more samples to improve accuracy
- Validate the ESG score formula on slide 15 by comparing the scores in some standard exams on the market

NEXT: Q&A